Quantifying Impervious Surface Change in Western Washington with Landsat Time Series Data

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Key Challenges I

- Urban heterogeneity
- Landsat grain size limitations

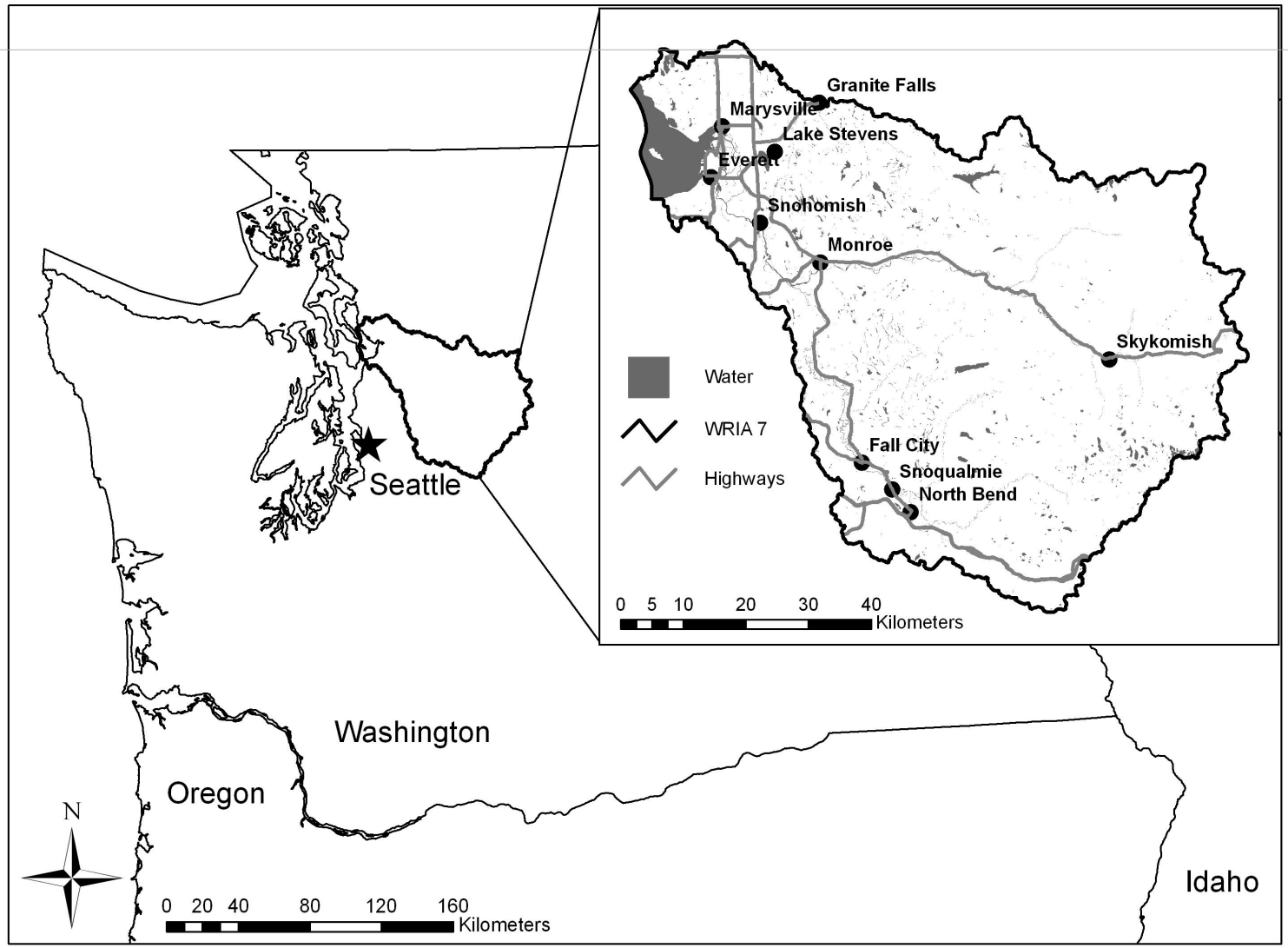
- Solution: spectral unmixing to determine sub-pixel land cover composition

Key Challenges II

- Distinguishing between land cover and land use

- Solution: leverage spatial and temporal contexts to augment spectral information

Study Area

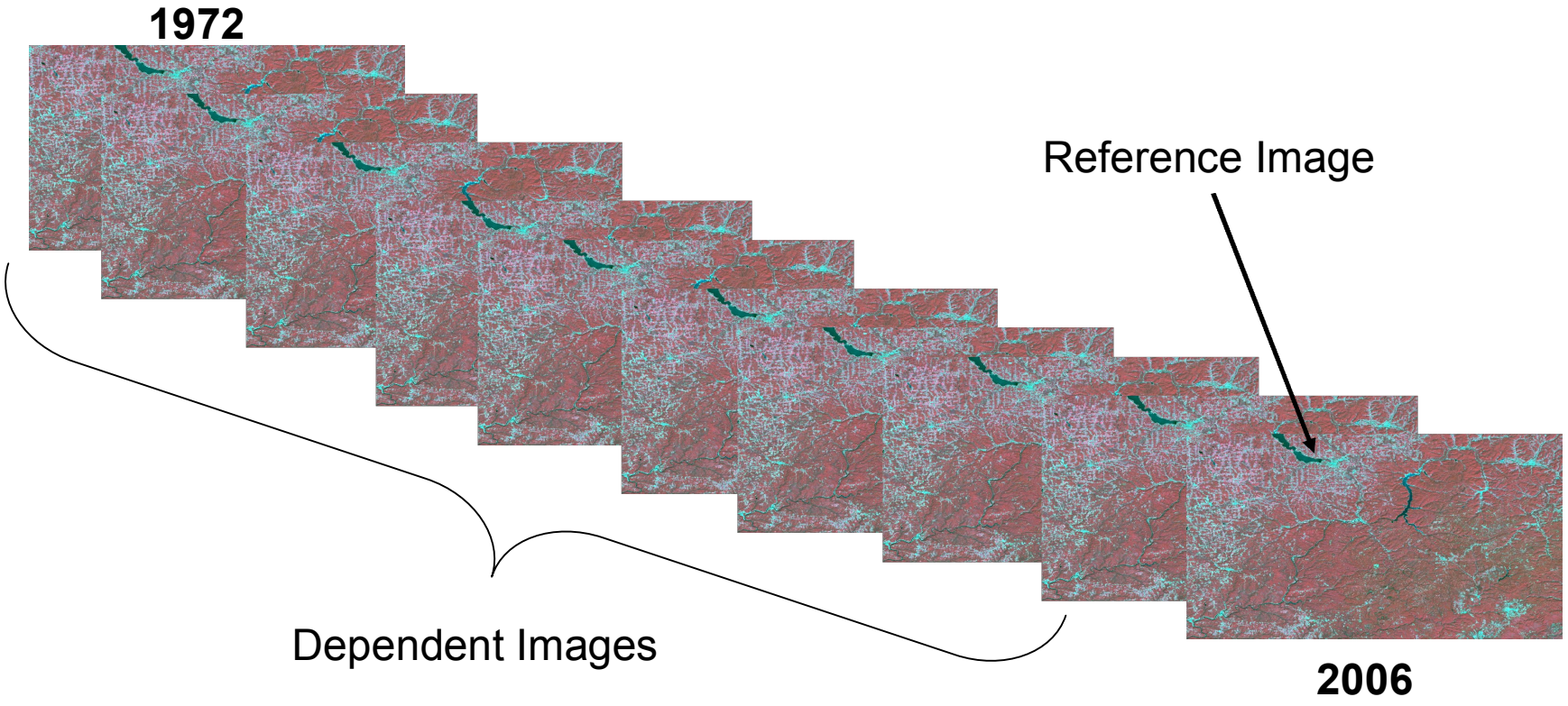

Granite Falls
Marysville
Lake Stevens
Everett
Snohomish
Monroe
Skykomish
Water
WRIA 7
Highways
Fall City
Snoqualmie
North Bend
0 5 10 20 30 40
Kilometers
Seattle
Washington
Oregon
Idaho
N
0 20 40 80 120 160
Kilometers

Landsat Image Stack

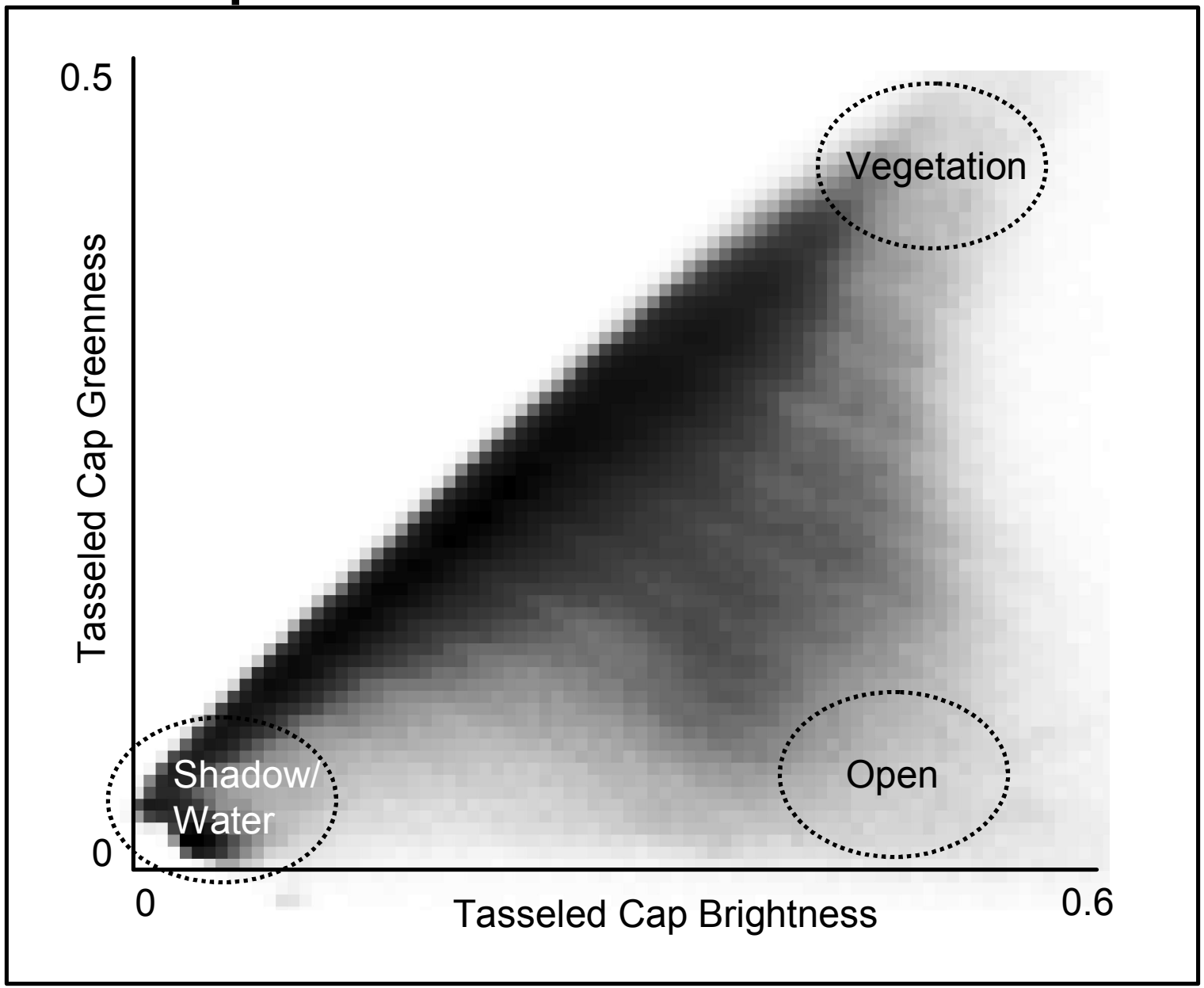
Date	WRS path/row	Sensor
07/29/1972	WRS1 50/27	Landsat 1 MSS
07/23/1975	WRS1 50/27	Landsat 2 MSS
08/03/1978	WRS1 50/27	Landsat 3 MSS
08/23/1981	WRS1 50/27	Landsat 3 MSS
08/23/1985	WRS2 46/27	Landsat 5 TM
08/31/1988	WRS2 46/27	Landsat 5 TM
09/22/1990	WRS2 46/27	Landsat 5 TM
08/29/1993	WRS2 46/27	Landsat 5 TM
08/21/1996	WRS2 46/27	Landsat 5 TM
08/27/1998	WRS2 46/27	Landsat 5 TM
09/25/2000	WRS2 46/27	Landsat 7 ETM+
08/14/2002	WRS2 46/27	Landsat 7 ETM+
09/02/2006	WRS2 46/27	Landsat 5 TM

Radiometric Normalization

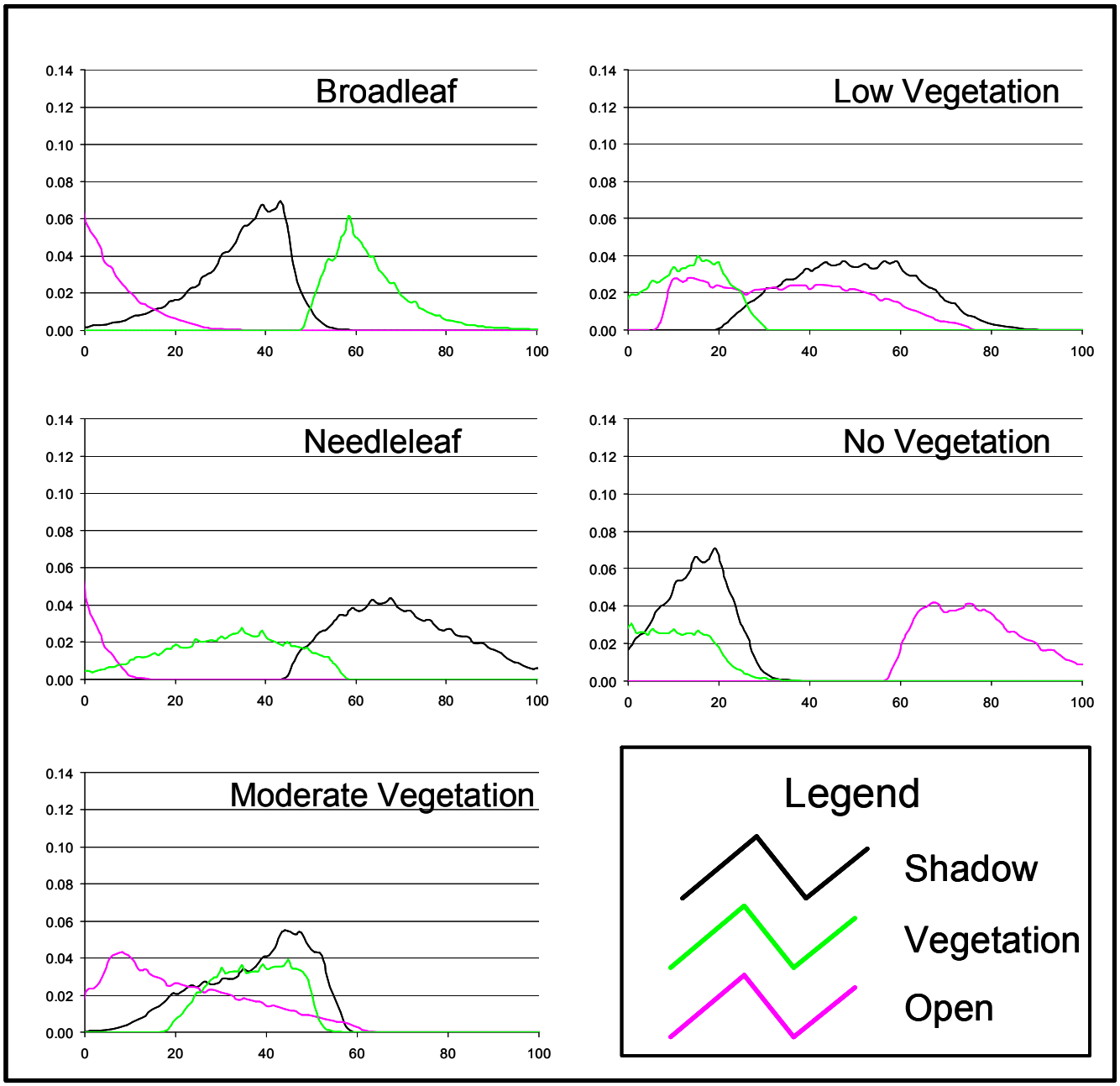
- Multivariate Alteration Detection (MAD) (Schroeder et al. 2006, *RSE*)



Spectral End-Members



End-member Frequency Distributions



Spatial Context

Rule #2: Unmasked Areas

Low Vegetation = Low Impervious

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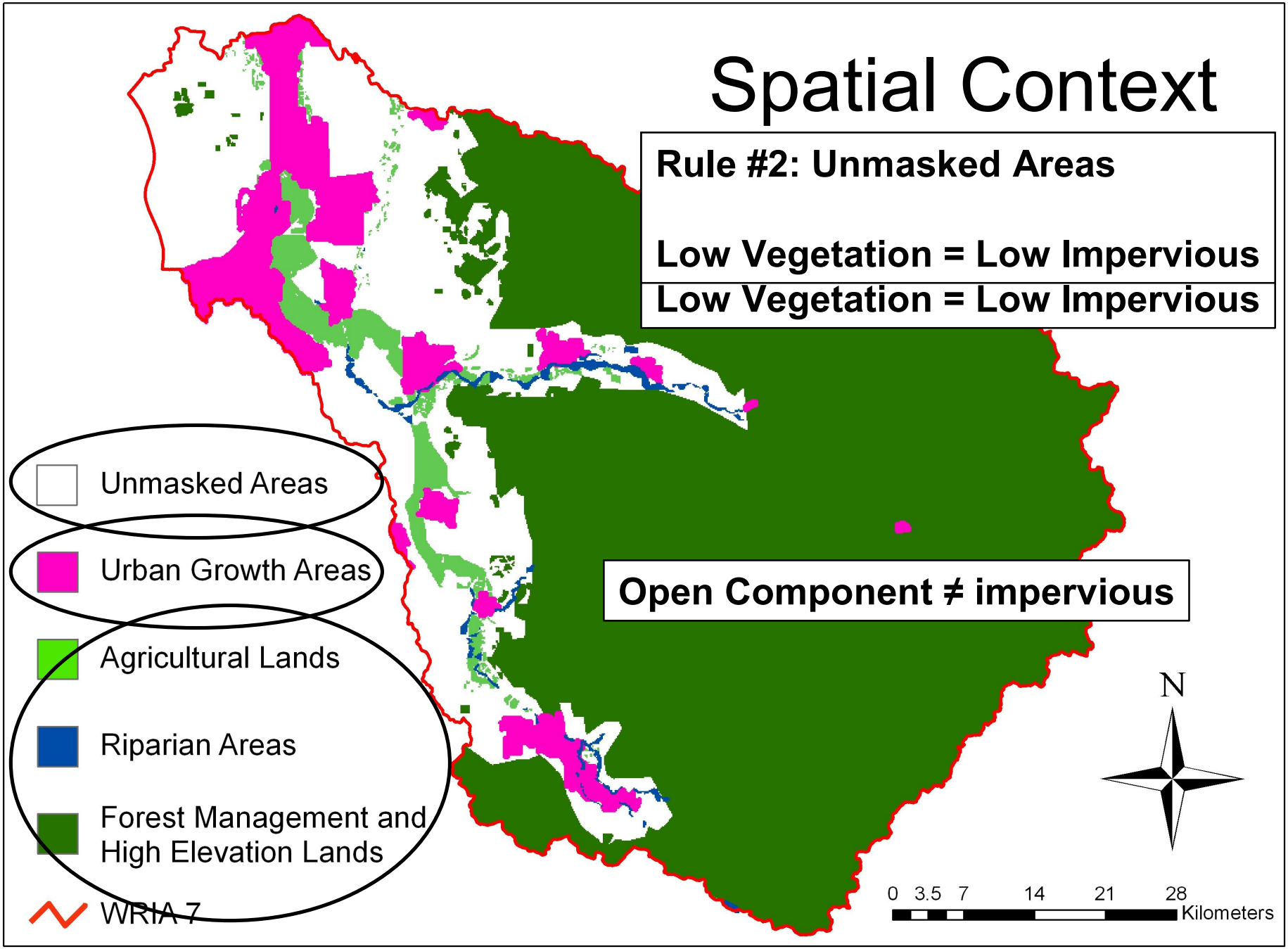
Open Component ≠ impervious

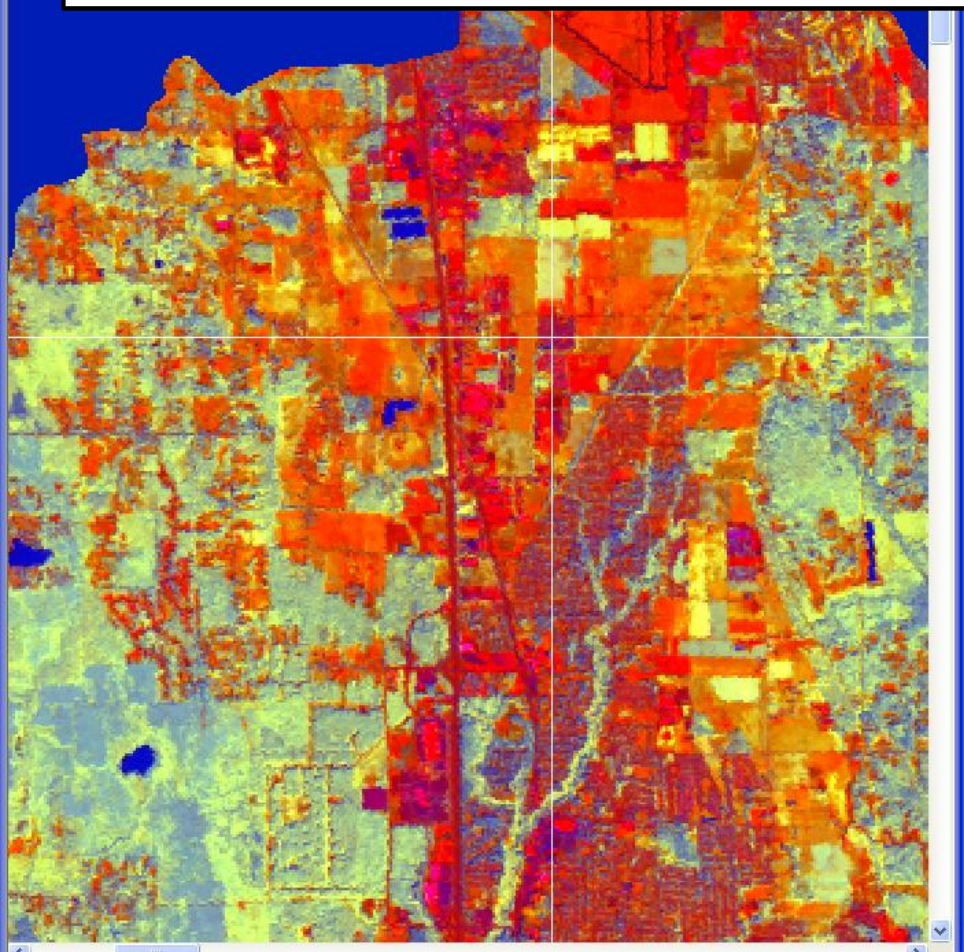


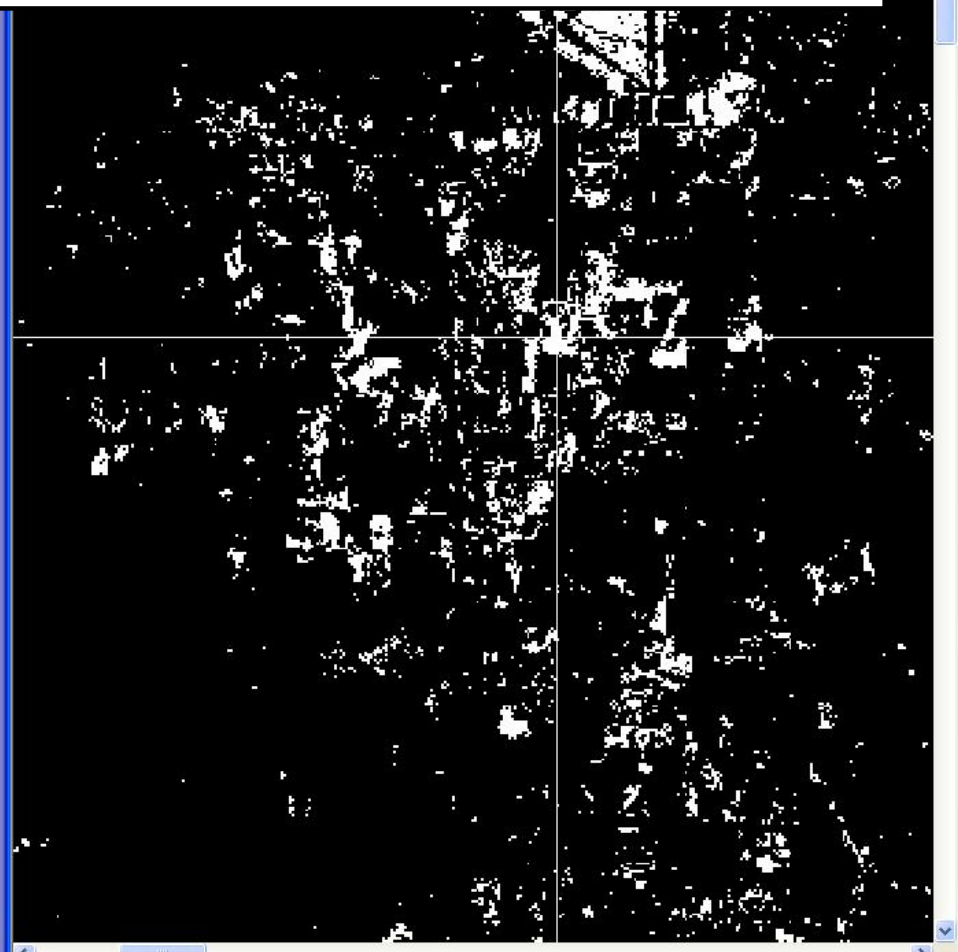
Temporal Context

- Rule #1: Frequent or unlikely changes in impervious amount
  - Associated with vegetation management or phenology – not impervious
- Rule #2: Non-reversal rule
  - Once impervious, always impervious

Temporal Context Example:

- Agricultural fields misclassified as impervious surface.
- Reclassified back to no- or low-vegetation

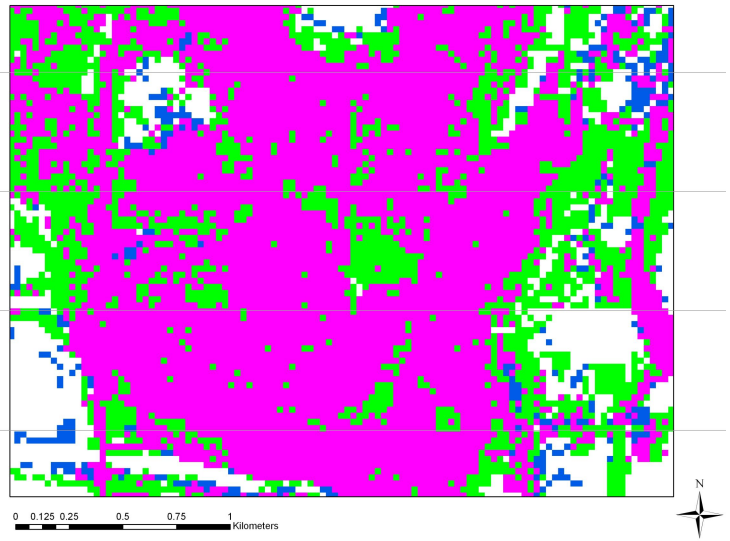




561334.24, 5325154.35 (UTM / WGS 84)

Validation

1. Defined classes by interpreting fractional composition of conifer, broadleaf, grass, open, and impervious
2. Derived a discriminant function to predict class membership for independent data
3. Collected date invariant reference data (6 of 13 dates)
4. Compared observed vs. predicted class membership



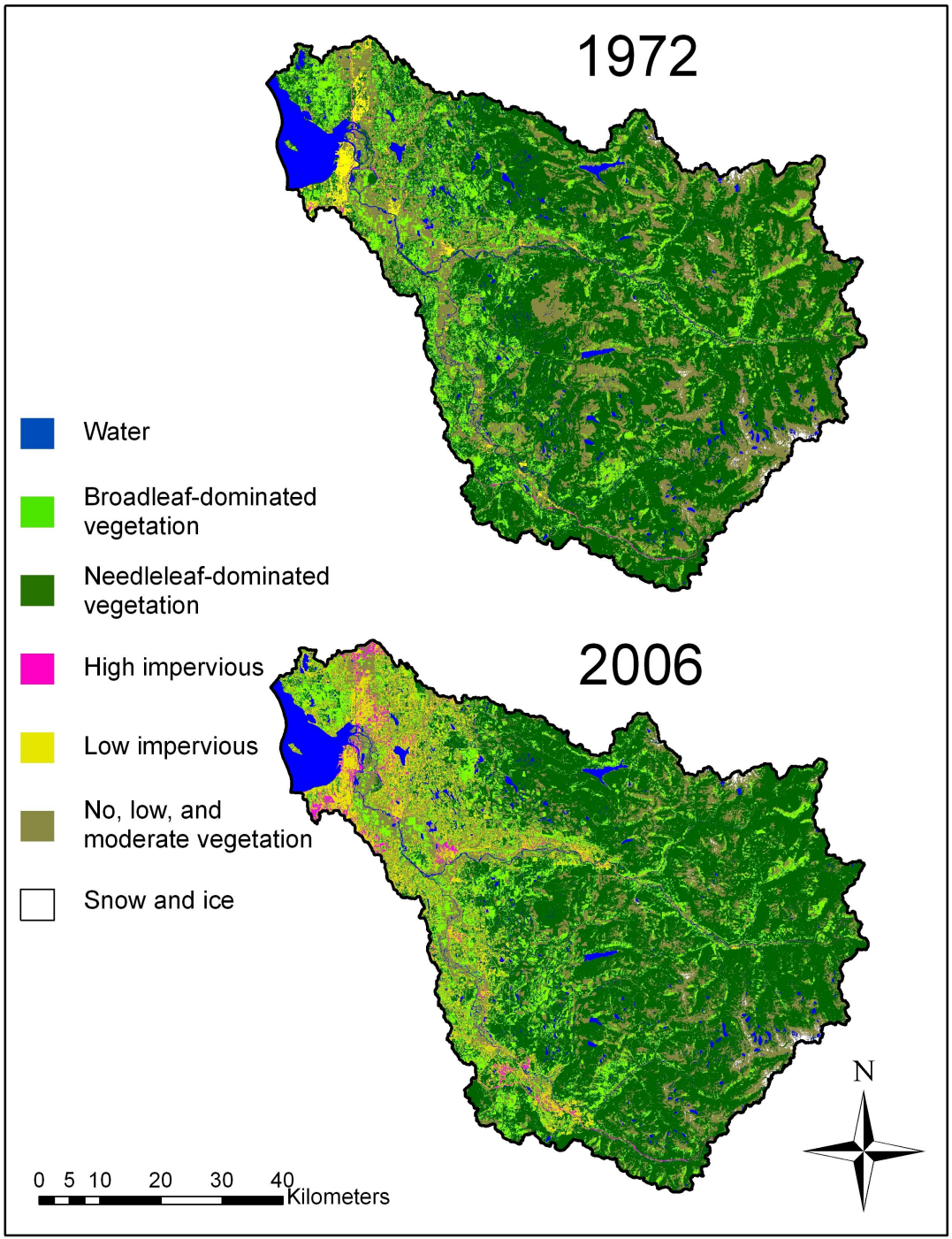
Accuracy

Impervious vs. Non-Impervious:

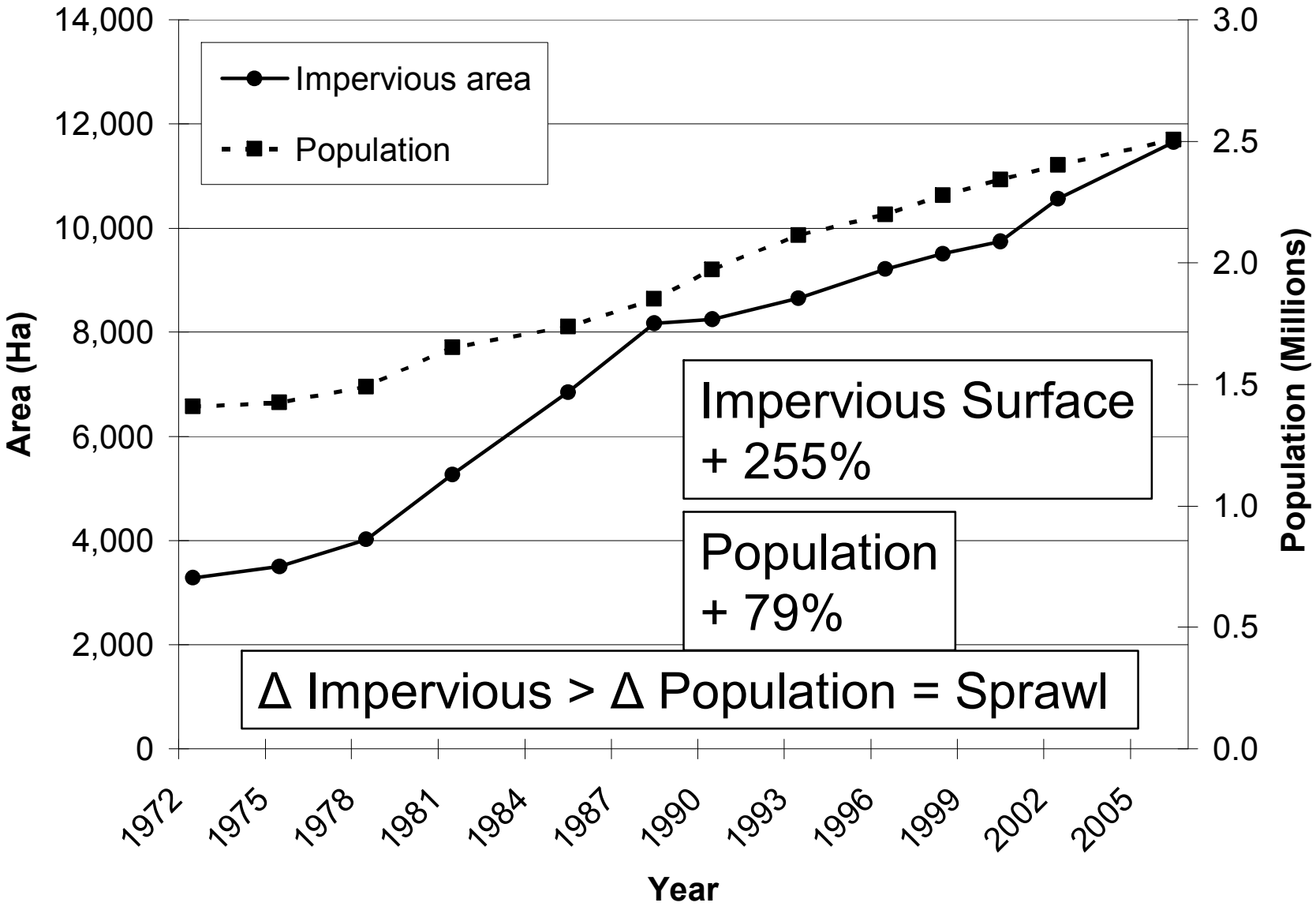
- 95%

All Classes:

- 76%



Impervious Surface and Population Trends



Conclusions

- Time series of Landsat imagery is effective for quantifying impervious surface change
- Moderate resolution and heterogeneous urban environment necessitate sub-pixel unmixing approach
- Spectral information alone is inadequate
  - Need to incorporate spatial and temporal contexts